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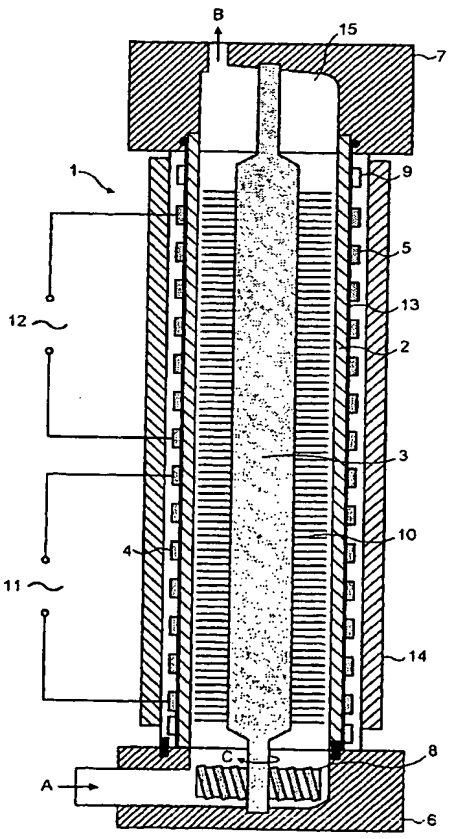
(54) Title: A LIQUID HEATING MODULE, A SYSTEM COMPRISING SAID MODULE AND A PROCESS FOR HEATING LIQUID



(57) Abstract: The present invention concerns a liquid heating module for use in a hot beverage machine, which comprises a hollow tube (2) of metallic material, a cylindrical insert (3), which is disposed inside the hollow tube, along its entire length and substantially along its axis of symmetry, at least one electrical resistor (4) on a first part of the outside of the tube for preheating liquid flowing through said hollow tube and at least one other electrical resistor (5) on a second part of the outside of the tube for temperature adjustment of the liquid flowing through the tube.

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For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

A liquid heating module, a system comprising said module and a process for heating liquid.

The present invention concerns a liquid heating module for use in a hot beverage machine. The invention concerns further a system comprising said module and a process for the heating of a liquid.

In the area of coffee machines, it is already known to have a thermoblock-heater in the machine, wherein said heater is permanently under power and allows hot water to be obtained at the moment when the consumer decides to operate the machine for preparing a coffee. The problems with this solution are following : first, there is a temperature inconsistency, that is, it is not possible to have a temperature of water permanently in a specific range, like between 85 and 90 °C. This has a negative influence on the quality of the obtained coffee. Secondly, the block-heater used is very heavy, which is not convenient when the coffee machine has to be moved. Thirdly, there is an energy inefficiency, because of the lost of energy during all the time the machine is under power.

The aim of the present invention is to minimize all the three above mentioned problems. The present invention allows to provide the consumer a system of heating with a very accurate range of temperature, without a machine all the time under power and with a very light heating device.

The present invention concerns a liquid heating module for use in a hot beverage machine, which comprises

- a hollow tube of metallic material,

- at least one electrical resistor on a first part of the outside of the tube for preheating liquid flowing through said hollow tube and
- at least one other electrical resistor on a second part of the outside of the tube for temperature adjustment of the liquid flowing through the tube.

The liquid which has to be heated in the module of the invention is not critical and can be any type of liquid. Preferably, the liquid heated is water, for example for preparing tea, coffee or other types of beverages. It is also possible to heat milk, for example for the preparation of cocoa beverages. The generation of steam can also be considered, for example for heating directly water in a cup or for foaming milk. The use of the heating module can be considered for small machines, like coffee machines or bigger machines , like vending machines.

Concerning the electrical resistor for the first part of the tube, in the case of a coffee machine, one or two resistors are present, in the case of a vending machine, it is possible to have 1 to 5 resistors. Concerning the electrical resistors for the second part of the tube, the same number of resistors applies as for the first electrical resistor. More preferably, only one resistor is used.

The material for the hollow tube is a metal. Preferably, the tube is made of stainless steel. The size of the tube can vary, depending on the type of use. For example, if it is used for a coffee machine, it can have a diameter of about 6 to 20 mm and a length of about 100 to 200 mm. The thickness of the tube is around 1 to 4 mm. In the case of a use in a vending machine, the tube has a diameter of about 30 to 50 mm and a length of about 200 to 400 mm. The thickness of the tube is the same as before.

The ratio of the length of the hollow tube to the diameter of said tube is comprised between about 5 and about 40.

The heating module according to the invention comprises further a cylindrical insert, which is disposed inside the hollow tube, along its entire length and substantially along its axis of symetry. The fact that an insert is present enhances heat transfer form the tube surface to the liquid with the heating element under power. This allows a good transfer of energy and a quick heating of the water. The insert is made of plastics or metallic material, which is food grade and could be of a good thermal conductivity. The insert is preferably made of copper or teflon (tetra-fluoro-ethylene). The ratio of the diameter of the hollow tube to the diameter of the insert is comprised between 2 and 5. It is possible to have either a fixed insert or an insert, which can be rotated along its axis of symetry. In the case of a rotating insert, said insert is connected with a rotating wheel of a flowmeter disposed at the lower part of the insert and so it can be powered by the flowing cold water, which flows in a tangent angle on to the flowmeter propeller. The rotatable cylindrical insert comprises a metal wire brush. These metal brush bundles are integrated through the insert in a longitudinal plane (on one side only or or two symetric sides of the insert) or on a spiral way, for example 1 or 2 spirals. They are built only in the insert part inside the hollow tube. The brush should be of proper mechanical tensile and strength so that it can descale the inner tube surface. Both the brush bundle ends should be slightly contacted with the inside surface of the tube at 90° C. The whole bundles should be designed to push water upwards when it is powered to rotate by the flowmeter propeller.

tube is permanently connected to power and the electrical resistor on the second part of the tube is connected to power and not connected to power according to a certain frequency depending on the required end temperature.

It is possible according to the process of the invention to heat in a few seconds from the room temperature to 85-90 °C the water, without the need of having the machine permanently switched on. The heating of the electrical resistors only occurs when the consumer ask for a coffee. The first electrical resistor, for example increases the temperature of the water from 20 to around 60 °C, and the second group of electrical resistor only needs to increase from 60 to 85 °C. Therefore, you do not need to have permanently a heating on this second electrical resistor. In this case, the electrical resistor on the second part of the tube is connected to power during about 50 to 100 % of the time at full power.

The second resistor is turned on and off in a percentage of time so that the outlet temperature is correct, in case of variation of electrical line voltage and flow rate. The wattage of this group of resistor is in such values that the on/off adjustment will not generate flickers.

In the case of the first embodiment of the system of the invention, that is a coffee machine, the flow rate of the water to be heated is comprised between 150 and 300 ml/min. In the case of a vending machine, the flow rate of water is comprised between 300 and 1000 ml/min.

As already said before, it is useful to have a control of the temperature of the heated water. In this case, the temperature of the liquid at the exit of the tube is measured, so that if the temperature is too high the electrical resistor on the second part of the tube is

stopped and if the temperature of the liquid is not high enough, this electrical resistor continues to be connected to power.

The invention is now described in more detail in relation with the drawings, wherein

Fig. 1 represents a schematic view of the liquid heating module of the invention,

Fig.2 represents a schematic view of a coffee machine comprising the module of figure 1 and

Fig. 3 represents a schematic view of a vending machine comprising the module of figure 1.

The heating module (1) comprises a hollow tube (2) made of stainless steel, a cylindrical insert (3) made of plastic (Teflon), a first electrical resistor (4) on the first part of the tube and a second electrical resistor (5) on the second part of the tube. Both of these electrical resistors are made of a thick-film and are connected to the power (11,12). The direction of the flow of water in the hollow tube is given by arrows A and B. The hollow tube is vertically installed to minimize air or steam accumulation inside the tube. Both ends of the insert are fixed on the cold water cap (6) and on the hot water cap (7). The insert (3) is connected to the rotating wheel of the flowmeter (8) and so it can be powered by the flowing cold water and rotates according to arrow C. A resistor (9) is furthermore disposed at the end of the hollow tube for measuring and controlling the temperature of the hot water leaving the module. Metal brush bundles (10) are built on the insert inside the hollow tube. A dielectric insulation (13), like enamel is painted on the tube under the resistors. For avoiding a too high loss of energy and guaranteeing a better safety an insulation (14) covers the resistors on

the entire height of the hollow tube. A free space (15) is provided into the hot water cap (7) for the buffering and the collecting of generated steam and separated air.

The liquid heating module operates as follows: when the consumer decides to prepare a beverage, both resistors (4,5) are under power. Resistor (4) remains permanently under power during the flowing of water through the hollow tube, whereas resistor (5) is switched on and switched off according to a certain frequency based on the remained required demand of energy to reach the final temperature of water necessary for the preparation of coffee. For example, resistor (4) allows an increase of temperature from 20 to 65 °C and the second resistor (5) has then only to provide the energy for increasing the water temperature from 65 to 85 °C. Because of the flowing of the water, the flowmeter (8) rotates and drives with it the insert (3). The metallic brush (10) on the insert avoids any deposit of calcium on the inside of the hollow tube.

Figure 2 gives an embodiment of the use of module (1) in a coffee machine. The machine comprises a cold water tank (16) connected through a pipe (17) to a pump (18) delivering the cold water to the heating module (1). At the exit of the module (1), the hot water flows through a conduit (19) and arrives on a cartridge (20) containing roast and ground coffee. This cartridge is a sealed cartridge opening under pressure according to the EP patent No. 512'468. The ready to drink coffee flows in a cup (21). The coffee machine can integrate further elements, like a valve, electronic controls.

Figure 3 gives a second embodiment of the use of module (1) in a vending machine. The cold water of the tank (22) flows through a pipe (24) with the help of a pump (23) in the heating module (1). At the exit of said module, the water

reaches a temperature of around 85 °C and flows through conduit (25) to a mixer (26). Simultaneously with the arrival of hot water, powder, like coffee powder is fed in the mixer from a powder storage (27) through a screw or auger (28) and said powder is mixed with the hot water and delivered in a cup (29). As already said before, the present machine can also integrate further elements normally present in such kinds of machines.

The specification is now made in relation with a specific example related with a heating module for a coffee machine.

Example

A stainless steel hollow tube having a diameter of 12mm with a length of 160 mm is used. The insert is made of plastic and has a diameter of 4 mm and the same length as the hollow tube. The resistors (4) and (5) have each a power of 600 Watts. The tube must support a pressure of max. 20 bar. The water flows with a flow rate of 200 ml/min. The required temperature is reached within 7 sec. And the second resistor is on during 60 % of the time. With this heating module, the temperature is very constant with the time and has only variation around 2 °C.

15) A process for heating a liquid, wherein said liquid is fed through the liquid heating module according to any of claims 1 to 13 at a flow range comprised from 150 to 1000 ml/min and brought to a temperature of about 85 to 90 °C in 3 to 10 seconds and wherein the electrical resistor on the first part of the tube is permanently connected to power and the electrical resistor on the second part of the tube is connected to power and not connected to power according to a certain frequency depending on the required end temperature.

16) A process according to claim 15, wherein the electrical resistor on the second part of the tube is connected to power during about 50 to 100 % of the time at full power.

17) A process according to any of claims 15 or 16, wherein the flow rate is comprised between 150 and 300 ml/min for a coffee machine and between 300 and 1000 ml/min for a vending machine.

18) A process according to any of claims 15 to 17, wherein the temperature of the liquid at the exit of the tube is measured, so that if the temperature is too high the electrical resistor on the second part of the tube is stopped and if the temperature of the liquid is not high enough, this electrical resistor continues to be connected to power.

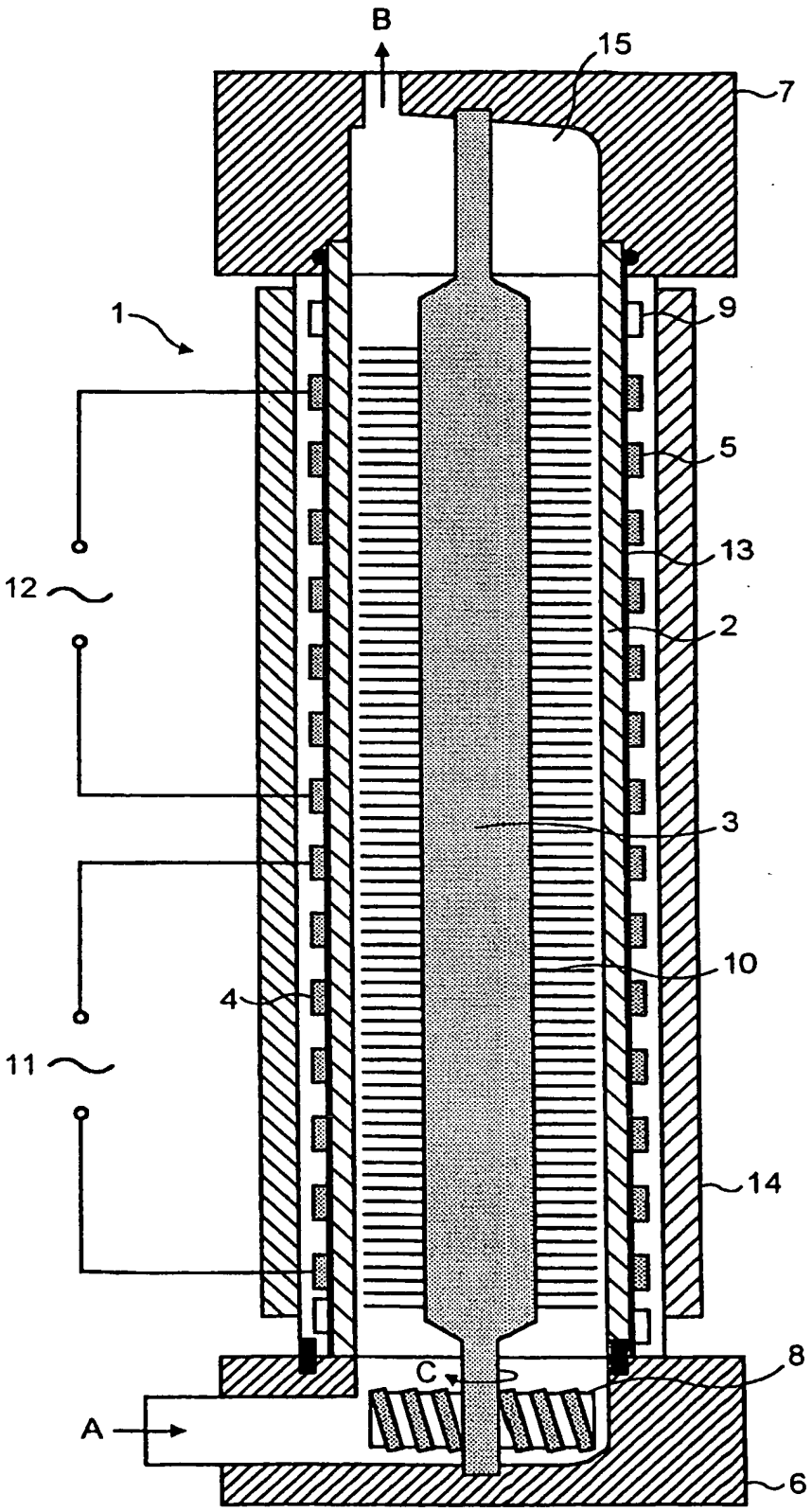

FIG. 1

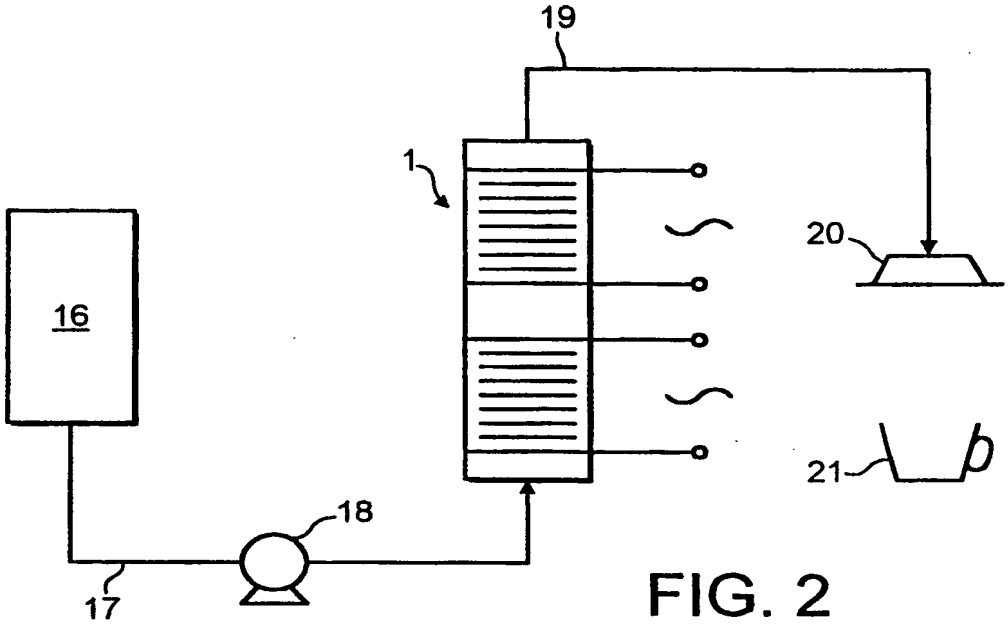

FIG. 2

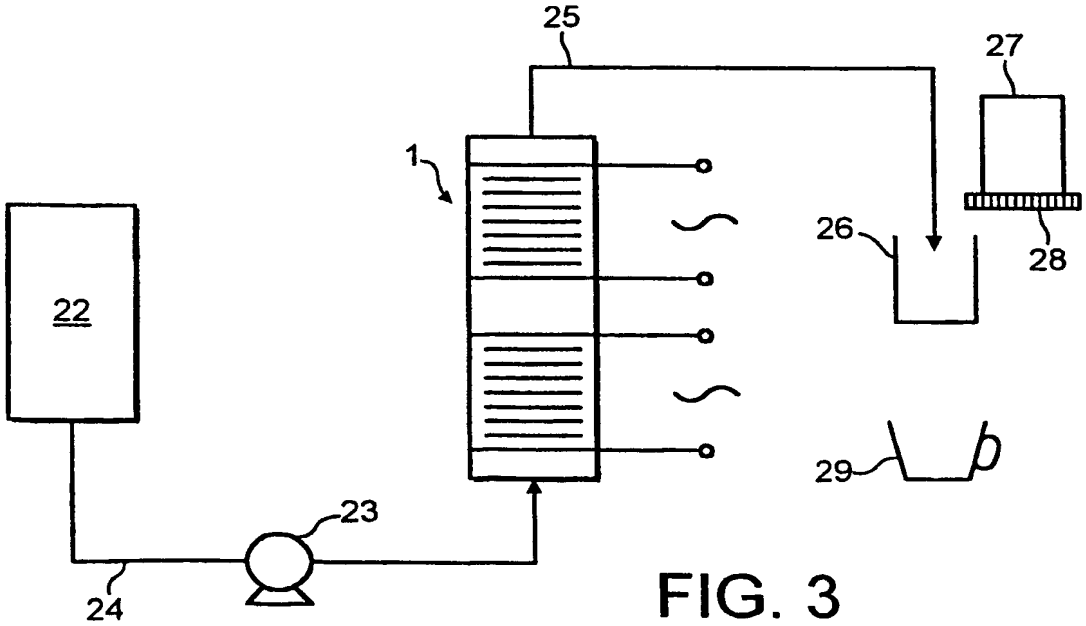

FIG. 3

INTERNATIONAL SEARCH REPORT

International ication No
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A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 A47J31/54

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 A47J

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal, WPI Data, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5 943 472 A (ROUGHES ALEXANDRE ET AL) 24 August 1999 (1999-08-24)	1,2,6
A	column 2, line 22 -column 4, line 67; figures	14,15
X	NL 8 101 610 A (PHILIPS NV) 1 November 1982 (1982-11-01) the whole document	1,2,14, 15
X	DE 40 38 462 A (MELITTA HAUSHALTSPRODUKTE) 4 June 1992 (1992-06-04) claims; figures	1,14,15
A	US 3 898 428 A (DYE WILLIAM G) 5 August 1975 (1975-08-05) abstract; figures	1-18

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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
13 June 2001	22/06/2001

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Acerbis, G

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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication,where appropriate, of the relevant passages	Relevant to claim No.
A	US 4 531 046 A (STOVER KENNETH W) 23 July 1985 (1985-07-23) page -; figures	1-18
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INTERNATIONAL SEARCH REPORT

Information on patent family members

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